Effect of the Dose and Frequency of IPM Lab Biopesticide on Collar Rot Incidence and Growth of the Indian Spinach

Salma Jahan Nipa[1], and M. Bahadur Meah[2]

Abstract— The effectiveness of integrated pest management (IPM) Lab biopesticide (Trichoderma based) in reducing collar rot disease and growth parameters of Indian spinach was studied. Five different levels of biopesticide (0, 10, 15, 20 and 25 g/m^2 of soil) at two frequencies were applied in the soil. Biopesticide was first mixed up with top soil during final land preparation and then one month after transplanting with rhizosphere soil of the plants. Results showed that increasing biopesticide level up to 25g/m^2 and its repeated application reduced collar rot disease incidence and increased growth parameters. Plant height, number of leaves and plant weight were markedly influenced by application of the biopesticide. Highest percent plant infection and lower growth were observed in the untreated plots. The highest dose (25g/m^2) of biopesticide used in the experiment supported significantly better growth and lower collar rot disease incidence. Thus, the experimental results have opened up a possibility of using Trichoderma based IPM Lab biopesticide over conventional farming inputs for sustainable and organic production of agro products vegetables.

Index Terms— Agro product, Collar rot, Dose, Frequency, Growth, Inidian spinach, IPM lab biopesticide, Plant infection

1 Introduction

THE indian spinach (Basella spp. Linn.) is one of the most important leafy vegetables and is a member of the family Basellaceae. There are five species of Basella of which B. alba and B. rubra are widely grown in Bangladesh. The vegetable is commonly known as puisak, Malabar spinach, Creeping spinach and Climbing spinach [1]. It is cultivated on 22000 acres of land with the total production of 63000 M. tons and the productivity of 2.87 tons/acre in Bangladesh (BBS, 2009). Among the various factors which limit the production of this crop, diseases play an important role. Sixteen different diseases of Indian spinach have so far been reported from different parts of the world (Ahmed and Hossain, 1985; Bose and Som, 1986). In Bangladesh only four diseases viz. leaf spot caused by Alternaria sp., Gloesporiam sp., and Cercospora sp., foot rot caused by Sclerotium rolfsil Sacc., anthracnose caused by Colletrichum sp. and Macrophomina leaf spot and stem rot caused by M. phaseolina have been reported (Ahmed and Hossain, 1985 Fakir, 1991. Collar/Foot rot is one of the major diseases caused by Sclerotium rolfsii of vegetables (Islam, 2006). Right from germination till harvest, Sclerotium rolfsii inflicts severe damage to the crop in all seasons. The pathogen attacks the collar zone of the host adjacent to the soil level causing death by disrupting translocation of food from top to root zone. Collar/Foot rot is a major constraint in successful cultivation of Indian spinach and eggplant mainly due to aggressive nature of the pathogen, its soil borne nature and continuous cropping of eggplant in many areas. Collar rot is a fungal disease caused by by Colletrichum sp. and Macrophomina leaf spot and stem rot caused by M. phaseolina have been reported (Ahmed and Hossain, 1985 Fakir, 1991. Collar/Foot rot is one of the major diseases caused by Sclerotium rolfsii of vegetables (Islam, 2006). Right from germination till harvest, Sclerotium rolfsii inflicts severe damage to the crop in all seasons. The pathogen attacks the collar zone of the host adjacent to the soil level causing death by disrupting translocation of food from top to root zone. Collar/Foot rot is a major constraint in successful cultivation of Indian spinach and eggplant mainly due to aggressive nature of the pathogen, its soil borne nature and continuous cropping of eggplant in many areas. Collar rot is a fungal disease caused by Sclerotium rolfsii Sclerotium rolfsii is chiefly soil borne and prefers damp, especially water-logged conditions. The disease of plants caused by soil borne pathogen are in general difficult to control. It has however, ben reported from various countries that fungicidal treatment of soil has some effect on the control of Sclerotium rolfsii and other soil borne pathogens (Backman and Kabana, 1975, Fellman, 1983). Biological control also tends to have more specific effects, with only the target pathogenic organisms being adversely affected, leaving other beneficial organisms and diverse soil microbial community intact to provide for healthier plants and roots Thus, biological control can be safer for human, the crop and the environment.

Trichoderma based biopesticides have gained considerable recognition as biological agent. Several strains of Trichoderma have been found to be effective as biocontrol agent of various soil borne plant pathogenic fungi such as Fusarium, Sclerotium, Rhizoctonia (Chet and Inbar, 1994). Trichoderma produces chemicals called trichodermin which is responsible for its antagonistic properties. Thus, T. harzianum may eco-friendly be used as a biocontrol agent and the nature will relatively be undisturbed and many beneficial micro-organisms in the soil will be saved. Kahem (2005) reported that soil treatment with Trichoderma harzianum and Trichoderma viride was effective for controlling foot and root rot of lentil (Fusarium oxysporum) and foot rot of tomato (Sclerotium rolfsii) in the inoculated field. It was determined the efficacy of IPM Lab biopesticide (Trichoderma formulated) against collar rot disease of

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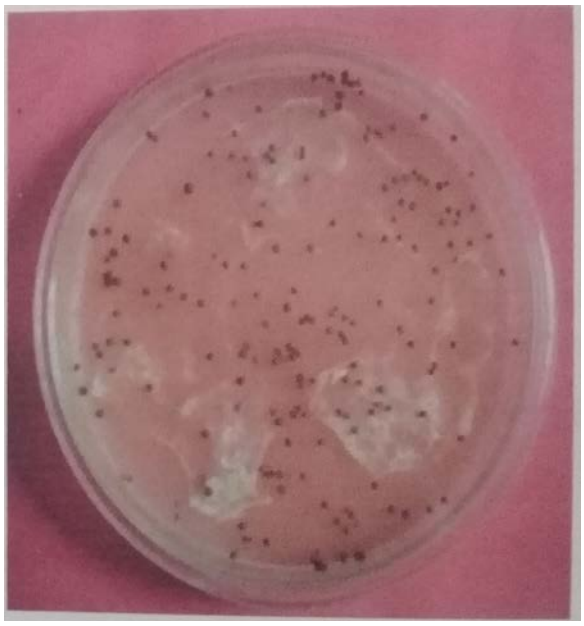
tomato, eggplant, Indian spinach, and sunflower. Islam (2008) observed the disease reaction of 54 eggplant varieties to foot/collar rot at early flowering stage and the effect of Trichoderma based biopesticide in reducing foot/collar rot. Faruque (2008) described that collar rot of 12 varieties of eggplant was decreased under field condition with the application of Trichoderma based biopesticide. The major limitation of biological control by Trichoderma species is the production of inoculum on large scale. To overcome the limitation, many researchers have worked on these problems. It was discussed the mass production of biocontrol agents (Gomez, 1984). It has frequently been pointed out that if the biological control of plant pathogens is to be accomplished on the field scale, it will be necessary to produce biocontrol agents in the form of spores or other propagules.

2 Experimental Methods

The experiment was undertaken to observe the performance of IPM Lab biopesticide on collar rot control and growth of Indian spinach. IPM Lab biopesticide was applied at five doses (0, 10, 15, 20 and 25 g/m^2) including control and at two frequencies. IPM Lab biopesticide applied in the soil significantly reduced the incidence of collar rot of Indian spinach. Culture of Sclerotium rolfsii in PDA. (a) Mycelia, 7 days old (b) Brown Sclerotia, 13 days old are shown in fig. 1. Fig. 2(a)-(b) show the (a) Barley culture of Sclerotium rolfsii 7 days old, and the (b) Air drying of barley culture of Sclerotium rolfsii. The difference is clear between the (a) Barley culture of Sclerotium rolfsii 7 days old, and the (b) Air drying of barley culture of Sclerotium rolfsii.

(a)

Fig. 1. Culture of Sclerotium rolfsii in PDA, (a) Mycelia, 7 days old



(b)

Fig. 1. Culture of Sclerotium rolfsii in PDA, (b) Brown Sclerotia, 13 days old.

(a) **(b)**

Fig. 2. (a) Barley culture of Sclerotium rolfsii 7 days old (b) Air drying of barley culture of Sclerotium rolfsii.

3 Result and Conclusions

Fig. 3 (a)-(b) depict that the (a) Inoculation of Indian spinach with Sclerotium rolfsii (10 g/plant) at the base of the plants (b) Wrapping with moist cotton to create favorable environment for the pathogen. A typical collar rot symptoms were seen at the base of Indian spinach is shown in Fig. 4. Fig. 5 demonstrates the Indian spinach recovered from infection. Repetition of its application at 60 days age (one month after transplanting) further reduced the disease. Percentage plant infection was reduced from 84 to 36 % as recorded after three months of biopesticide application in case of one-time application. For two-time application, percentage plant infection was reduced

from 68 to 28%. Lesion size was reduced from 2.1 to 0.8 cm as recorded after three months of biopesticide application in case of one-time application. For two-time application, lesion size was reduced from 1.4 to 0.4 cm. Percentage plant recovery was increased from 16 to 64% as recorded after three months of biopesticide application in case of one-time application. For two-time application, percentage plant recovery was increased from 32 to 72 %.

(a) **(b)**

Fig. 3. (a) Inoculation of Indian spinach with Sclerotium rolfsii (10 g/plant) at the base of the plants (b) Wrapping with moist cotton to create favorable environment for the pathogen.

Fig. 4. Typical collar rot symptoms were seen at the base of Indian spinach.

Plant height increased from 86.48 to 145.85 cm as recorded after three months of biopesticide application in case of one-time application. For two-time application, plant height increased from 107.44 to 171.45cm.

Fig. 5. Indian spinach recovered from infection.

Plant weight increased from 230.00 to 655.40 gm as recorded after three months of biopesticide application in case of one-time application. For two-time application, plant weight increased from 400.86 to 896.00 g. Leaf number increased from 32 to 87 as recorded after three months of biopesticide application in case of one-time application. For two-time application, leaf number increased from 41 to 93. Interaction between dose and frequency of IPM Lab biopesticide application in the soil significantly affected collar rot incidence and recovery from infection and influenced growth and yield of Indian spinach. The relationship between dose of biopesticide and percentage of collar rot infection in Indian spinach is shown in fig. 6. Percentage of plant infection varied from 13.33 to 100% for different treatments to without treatment. The best treatment was D_4, F_2 i.e. biopesticide applied two times @ 25 g/m^2 yielded the lowest plant infection. The second best treatment was D_4, F_1 or D_3, F_2 followed by D_2, F_2. Percentage plant infection had a linear relationship with the doses of biopesticide application. The percentage plant infection declined steadily with increase in doses. The decline in percentage plant infection was higher in repeated use of biopesticide (fig. 6). Fig. 7 shows the relationship between dose and frequency of IPM Lab biopesticide and level of collar rot infection and recovery of Indian spinach. At no biopesticide application, percentage of plant infection was hundred with no recovery. With increase in dose of biopesticide, the level of infection decreased while the percentage of recovery from infection increased. This phenomenon is more distinct for the repeated use of biopesticide. At the highest dose of biopcsticide used, percentage recovery from infection reached to 90% (fig. 7). With dose > 10 < 15 g/m^2 applied once, minimum recovery from infection of 40 % was achieved which reached to 80% for increase of dose to 25g/m^2. On the other hand, for repeated use of biopesticide dose 25g/m^2, a minimum of 50% plant recovery from infection could be achieved which was increased to 90% through up scaling of dose to 25g/ m^2 (fig. 7).

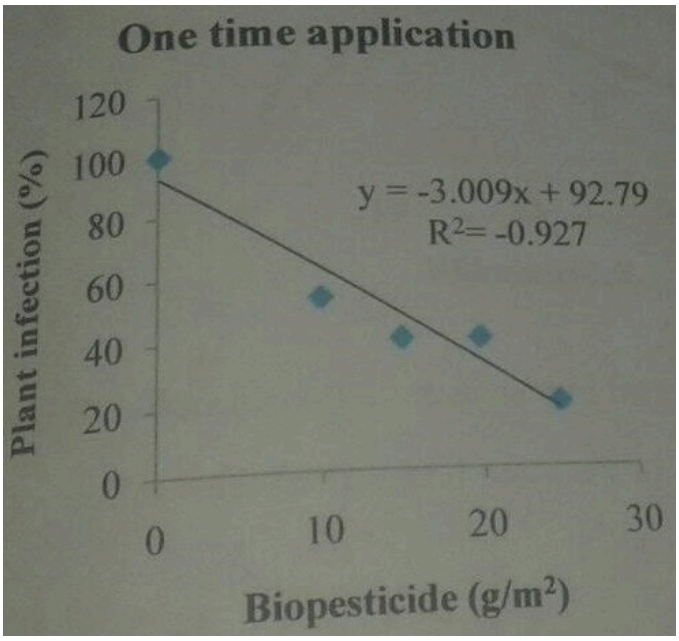


Fig. 6. Relationship between dose of biopesticide and percentage of collar rot infection in Indian spinach.

4 Summary and Conclusions

The experiments were conducted during Rabi season of 2010-2011 to assess the efficacy of IPM Lab biopesticide on controlling collar rot (Sclerotium rolfsii) and the promotion of growth of Indian spinach. IPM Lab biopesticide applied at four rats of 0, 10, 15, 20 and 25 g/m^2 were mixed with the soil and the land was kept fallow for seven days. Thereafter, healthy seedlings were transplanted at the age of 40 days in the field in the afternoon followed by watering. Observations were made on collar rot disease incidence and the crop growth. Parameters such as percent plant infection, lesion size, percent plant recovery, plant height, leaf number and plant weight were recorded.

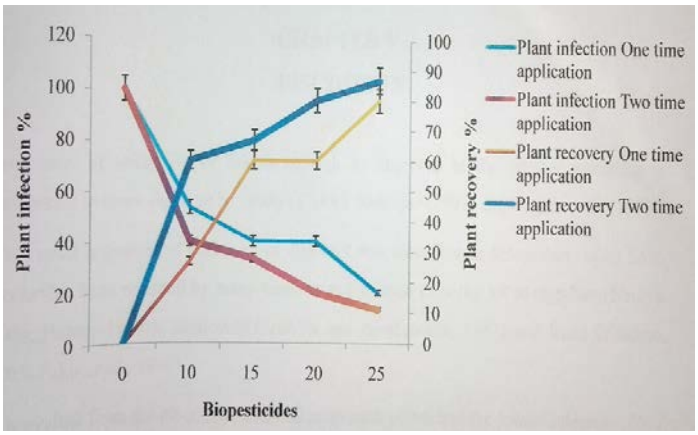


Fig 7: Relationship between dose and frequency of IPM Lab biopesticide and level of collar rot infection and recovery of Indian spinach.

Interaction study between IPM Lab biopesticide and Sclerotium rolfsii were conducted in field soil through inoculation near the plant base. The characteristic collar rot symptoms appeared as discoloration and rotting of plants cuticle at the base adjacent to soil surface with the presence of white mycelia and white (immature) along with brown (mature) sclerotia on infected plant parts and on soil surface near plant base. Application of biopesticide prepared out of Trichoderma at the IPM Lab of the Bangladesh Agricultural University had remarkable positive effect on plant growth and disease control. Biopesticide applied at 10, 15, 20 and 25 g per one square meter area significantly increased growth components and decreased collar rot disease incidence. The highest dose 25g/ m^2 used in the experiment supported significantly better growth and lower disease incidence. Percent plant infection of Indian spinach was highest (84%) in case of one-time application of biopesticide. The lowest percent plant infection was 28% in case of twice application of biopesticide, which also showed smallest lesion size, and highest recovery rate. Plant height (171.45 cm), plant weight (896 g), number of leaf per plant (92.78) were highest in case of two times application of biopesticide. Untreated and inoculated plants showed 100% plant infection, highest lesion size and no recovery from infection The highest dose 25 g/m^2 used in the experiment supported significantly lower collar rot disease incidence and better growth of Indian spinach. Field experiment was conducted to evaluate the potential results of biopesticide in controlling collar rot (Sclerotium rolfsii of Indian spinach. IPM Lab biopesticide was significantly effective in controlling collar rot disease of Indian spinach. The findings of this study clearly point out the possibility of using biopesticide as protective measure against collar rot disease of Indian spinach. Therefore, IPM lab biopesticide can be used as a sustainable agricultural input for agro products.

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References

[1] B. Choudhury, “Vegetables”, Sixth revised edition, National book

trust, India, 1967.
[2] BBS: "Statistical Yearbook of Bangladesh 2009, Bangladesh Bureau of Statistics", Ministry of Planning, Government of the People Republic of Bangladesh. Dhaka, Bangladesh, pp. 156, 2009.
[3] H. U. Ahmed, and M. Hossain 1985. "Crop disease survey and establishment of a herbarium and BARI: Final report of the project", pp. 107, 1985.
[4] T. K. Bose, and M. G. Som, 1986. "Vegetable Crops in India", B. Mitra Naya Prokash, 206 Bidhan Sarani, Calcutta 700006, India, pp. 775, 1986.
[5] G. A. Fakir, M. M. Rahman, and M. F. Islam, "Occurrence of diseases on lentil and country bean germplasms and their reaction to the selected major pathogens" Proc., Bangladesh Agricultural University Progress, Mymensingh, Bangladesh, pp. 1-10, 1991.
[6] M. M. Islam, "Molecular characterization of Phomopsis vexans and Solanum melongena and Transfer of a Phomopsis resistance trait to cultivar Dohazari", Ph. D. thesis, Dept. of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh, pp. 26-57, 2006.
[7] P. A. Blackman and R. A. Rodriguez Kabana, "A system for the growth and delivery of biological control agents to the soil", Phytopathology, 65:819, 1975.
[8] J. K. Fellman D. L. Tourneau and D. L. Stiers, "Effect of some carboxamide fungicides on growth and sclerotia formation of S. rolfsii", British Mycol. Soc. 80(1), pp 170-172, 1983.
[9] I. Chet, and J. Inbar, "Bioligical control of fungal pathogens", Applied Biochem, Biotech, 48(1), pp. 37-43. 1994.
[10] A. Kashem, "Trichoderma in controlling foot and root rot and collar rot of lentil", Ph. D thesis, Dept. of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh, pp. 192, 2005.
[11] M. S. Islam, 2008. "Incidence and severity of foot/collar rot in some varieties of eggplant and its control by Trichoderma based biopesticide" MS thesis, Dept. of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh, pp. 35-70, 2008.
[12] M. O. Faruque, "Genetic variation in eggplant cultivars through RPD (Random amplified polymorphic) marker and its relation to collar rot disease". MS thesis, Dept. of Plant Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh, pp. 92, 2008.
[13] M. I. Faruk, M. A. Bari, and M. A. Rahman, "Efficacy of Trichoderma as bio-control agent against foot and root rot of bush bean", Bangladesh J. Agri. Res. 27 (4), pp. 657-562, 2002.
[14] K. A. Gomez, and A. A. Gomez, "Duncan's Multiple Range Test. Statistical Procedure for Agri. Res." 2nd ed., Wiley Inter-Science Publication, Johan and Sons, New York, pp. 202-215, 1984.